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AIRS Project
Version 5.0 Development for FY'05

Plans and Accomplishments

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Most Enhancements planned in Sept 2004 for Version 5 have been implemented

- Level 1
  - Improved IR moon-avoidance
  - Microwave sidelobe correction
- Level 2
  - Water Vapor and Temperature Products
    - Reduced Bias
    - Reduced RMS Uncertainty →
    - Improved Sensitivity near the Surface
    - Improved Error Estimation
    - Minimal Tuning
    - AIRS Only Option
  - AIRS Surface Products
    - Improved SST @ 2x yield →
    - Improved land surface emissivity, no failure over desert and polar →
  - AIRS Composition Products →
    - Ozone Reduced biases
    - New products: CO, CH4
    - Aerosol and SO2 flag
    - CO2 in support product
  - Averaging Kernels on T, H_2O, O_3, CO, CH_4
  - Error Estimates on all products, all levels →
  - Revised ATBD
- Level 3
  - Improved Quality Control
  - New L3 Quantization (Statistically Optimal Summaries)
- Migrating to Linux

→ = more on this in a later talk

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Some Enhancements not planned for Version 5 have been implemented

- Level 2
  - RTA Spectroscopy Improvements
    non LTE implemented
    track global CO2 increase
- Level 3
  Formal error propagation

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Standard Product Activation / Validation Timeline

Version	4.0	5.0	6.0
Activation Date	4/05	12/06	8/08
Radiance Products (L1)	ocean/ land	Polar	Global
AIRS/AMSU Radiances	Val2	Val3	Val4
Standard Products (L2)			
Cloud-Cleared IR Radiance	Val2	Val3 ?	Val4
Surface Products	Val1	Val2 ?	Val4
Temperature Profile	Val2	Val3 ?	Val4
Humidity Products	Val1	Val2 ?	Val3
Cloud Cover Products	Val1	Val2?	Val3
Research Products			
Ozone Profile	Val1	Val2?	Val3
Carbon Monoxide Profile	Beta	Val1?	Val2
Methane Profile	Beta	Val1?	Val2
Carbon Dioxide (Mid Trop.)		Beta?	Val1
SO_2, Aerosols		Beta?	Val1

Beta = Not suitable for scientific investigations.

Val1 = non-polar, day/night, ocean.
Val2 = Val1 + land.
Val3 = Val2 + polar
Val4 = Global All Cases

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The V4 L2 algorithms are described in the updated ATBD (currently in final review)

The V4 validation results are documented in the peer reviewed JGR Special Validation Issue (2006)

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Detailed Level 1b Objectives for V5.0

- **Level 1**
  - **microwave**

    Planned: Side-lobe correction

    Actual: Scene Brightness temperature uses angle and channel dependent bias correction

    validate for land

  - **IR**

    update channel properties file

    improve Moon avoidance

    improve spectral centroid assignment per granule

    validate for polar

    Climate Quality Assessment

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The AIRS IR level 1b radiance calibration have remained essentially unchanged since September 2002

Changes deal with refinements like

- **better moon avoidance,**
- **better spectral centroid assignment**
- **better noise characterization**
- **dust flags etc.**

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AIRS L1B Changes, V4 to V5

- AMSU
  - *Brightness Temperature*
    - *now differs from Antenna Temperature by an empirical correction as a function of channel and scan angle*
  - *BT uncertainty also provided*
- New fields in IR L1B
  - *Dust flag*
    - *"dust_flag" field*
    - *"dust_score" field*
  - *SO2 flag*
    - *"BT_diff_SO2"*
- Other changes to IR
  - *Physical constants changed for consistency*
    - *Tiny changes, but affects all L1B IR radiances*
    - *Low temp, high frequency is worst case: 0.05% radiance change*
  - *Improved moon detection algorithm*
  - *Spectral uncertainty now has reasonable values*

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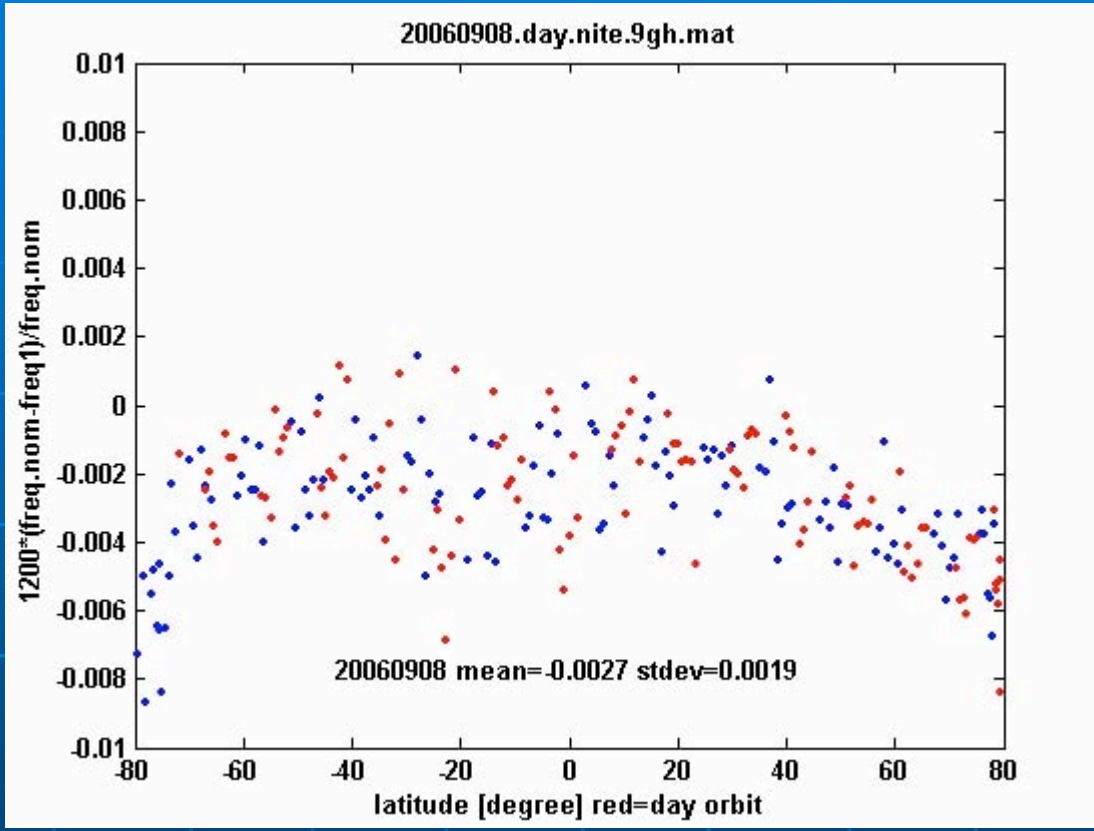
The AIRS level 1b frequency calibration per granule is good to 2 ppm, 10 ppm is required for weather forecasting



+/- 10 ppm frequency knowledge

The current frequencies are about 6 ppm higher than the nominal RTA frequencies
At the 1 ppm level there is no obvious day/night dependence of the frequencies
There appears to be an algorithm related 1 ppm latitude dependence

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AIRS L1B Changes, V4 to V5

- Other changes to IR (continued)
  - *New Channel Properties*
    - *Chan props have new frequencies for M-12*
    - *A new epoch beginning 2005/03/01 has been added to incorporate changes since previous epoch (2003/11/19)*
    - *Noise estimates based on end of epoch instead of beginning*
    - *Slightly different determination of A/B state from A/B weight*
    - *Merged "SRF Shape" and "SRF Fit" comments into "SRF Fit"*
    - *Convention of spatial centroids clarified; sign convention of x-centroid reversed*
    - *Channel that are unresponsive most of the time are now classified as "dead"*
    - *Deprecated*
  - *New Calibration Properties*
    - *Includes parameters (gain, NEN_250, NEN_300) from which to calculate scene-dependent noise*
    - *Includes min and max NEDT_250 over 10-day period*
    - *Includes quantitative non-gaussian metrics (npops and n3sigma)*
    - *Will replace Channel Properties files in V6*

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Global Validation of AIRS IR L1B Products completed with the day/night validation under polar conditions

Aumann et al. 2006 JGR paper

V. Walden et al. 2006 JGR paper

Broberg et al. 2006 San Diego SPIE paper

Aumann et al. 2006 ITOVS paper

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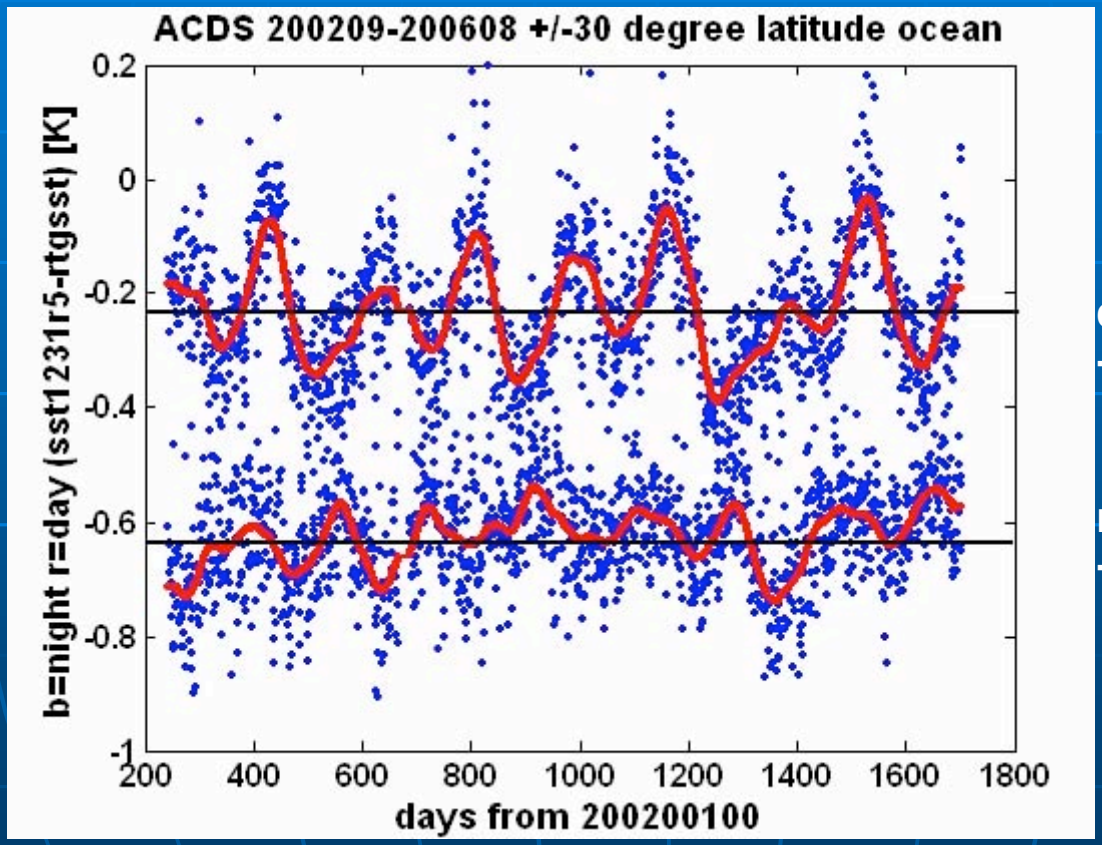
Each point is the daily mean of about 5000 clear spectra from ascending (day) and descending (night) orbits.

The red 32 day smoothed points illustrate seasonal variability.
All trends are calculated relative to the four year climatology



day
+6 +/- 3 mK/year

night
+9 +/- 3 mK/year

The small positive trend is due to a version change in the RTGSST in May 2004 (about day 850 in the figure)

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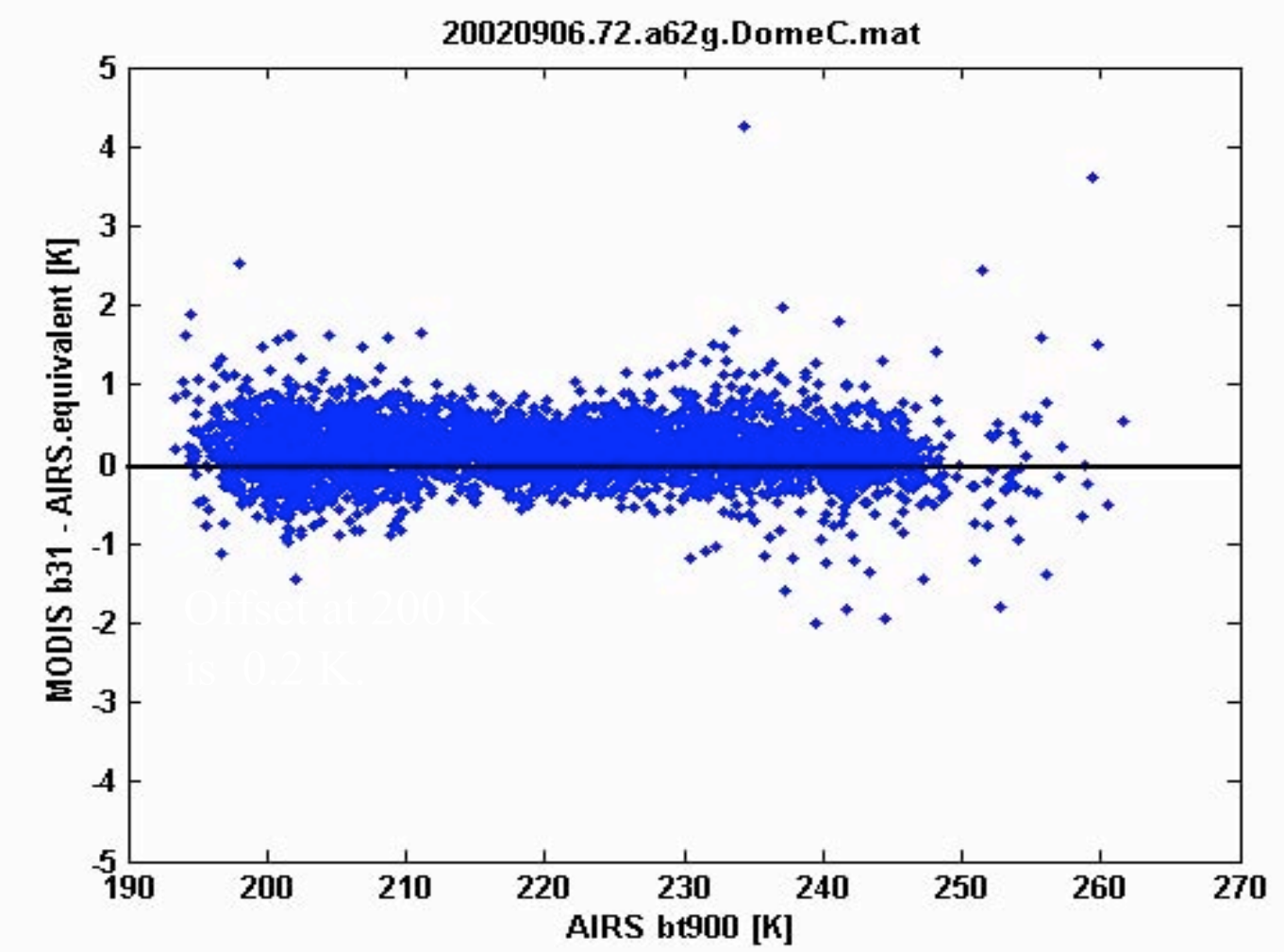
The 20020906 granule 72 Dome C overpass comparison of MODIS and AIRS agree within 0.2 K for the 195 – 250 K temperature range



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Level 1b Microwave (AMSU)

Validation of the AMSU radiometric performance is difficult

All microwave users (ECMWF, NCEP, UKMeto and AIRS L2) use time, scan angle and channel dependent empirical tuning.

For AIRS L2 a fixed additive correction as function of scan angle ("tuning") was determined empirically in 2002 relative to ECMWF using moderate and tropical ocean.

A more recent attempt to tune the AMSU channels sounding relative to equivalent AIRS channels using clear footprints did not result in significant improvement.

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There are potentially three ways to validate the AMSU stability:

1) Use the tropical ocean (surface and atmosphere)
This works for AIRS sounding channels

2) Evaluate AMSU stability relative to equivalent AIRS channel

3) (obs-calc.)

AMSU is actually three independent radiometers, each of which has to be validated

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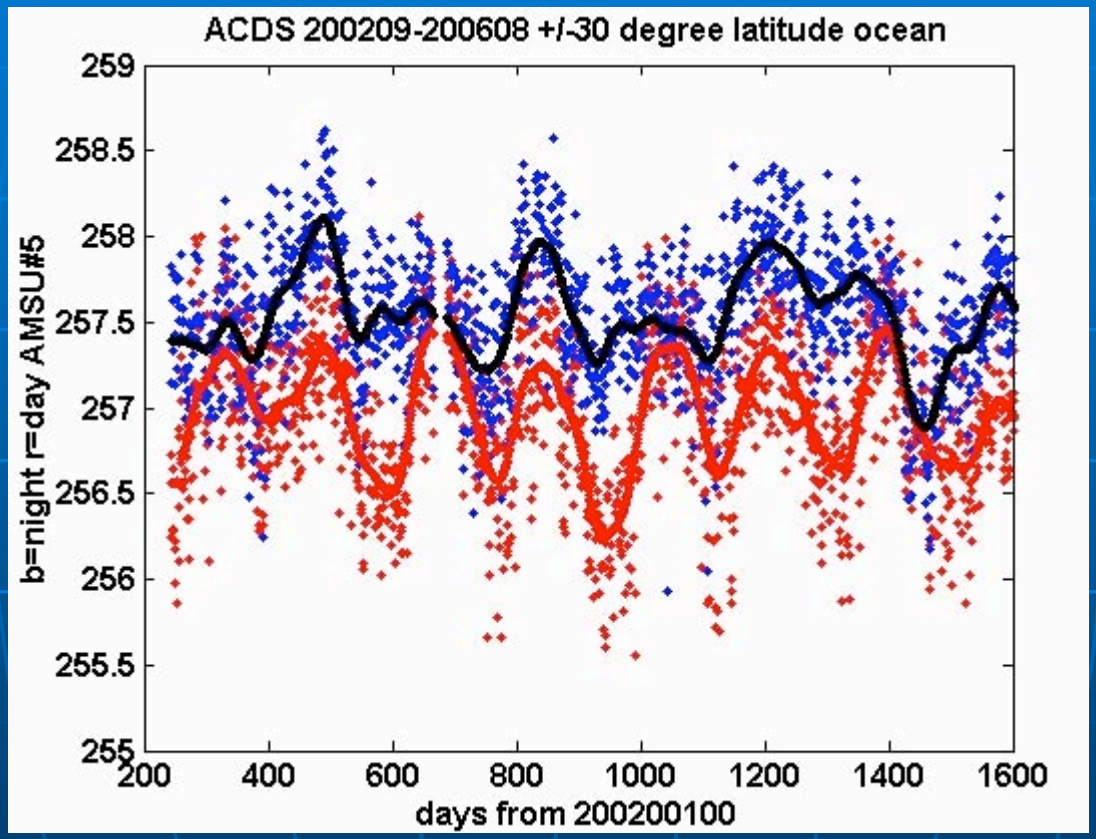
The tropical oceans can be used to directly assess instrument stability



Day trend of -21 +/- 14 mK/year of 257.0 K
night trend of -25 +/- 12 mK/year of 257.6 K
unexpected cooling

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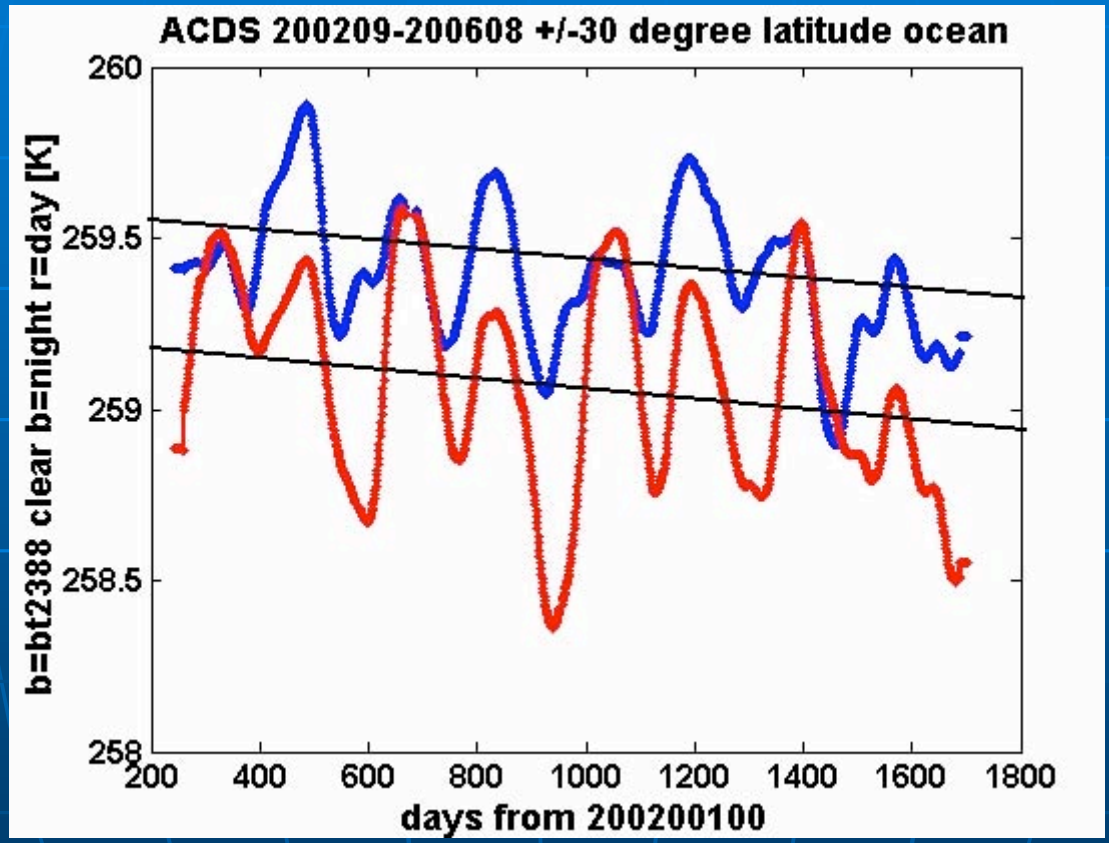
The same plot for bt2388 produces the expected co2 effect



Day trend of -63 +/- 13 mK/year of bt2388 and night trend of -62 +/- 10 mK/year are consistent and correspond to a 1.8 ppmv/year of co2 increase

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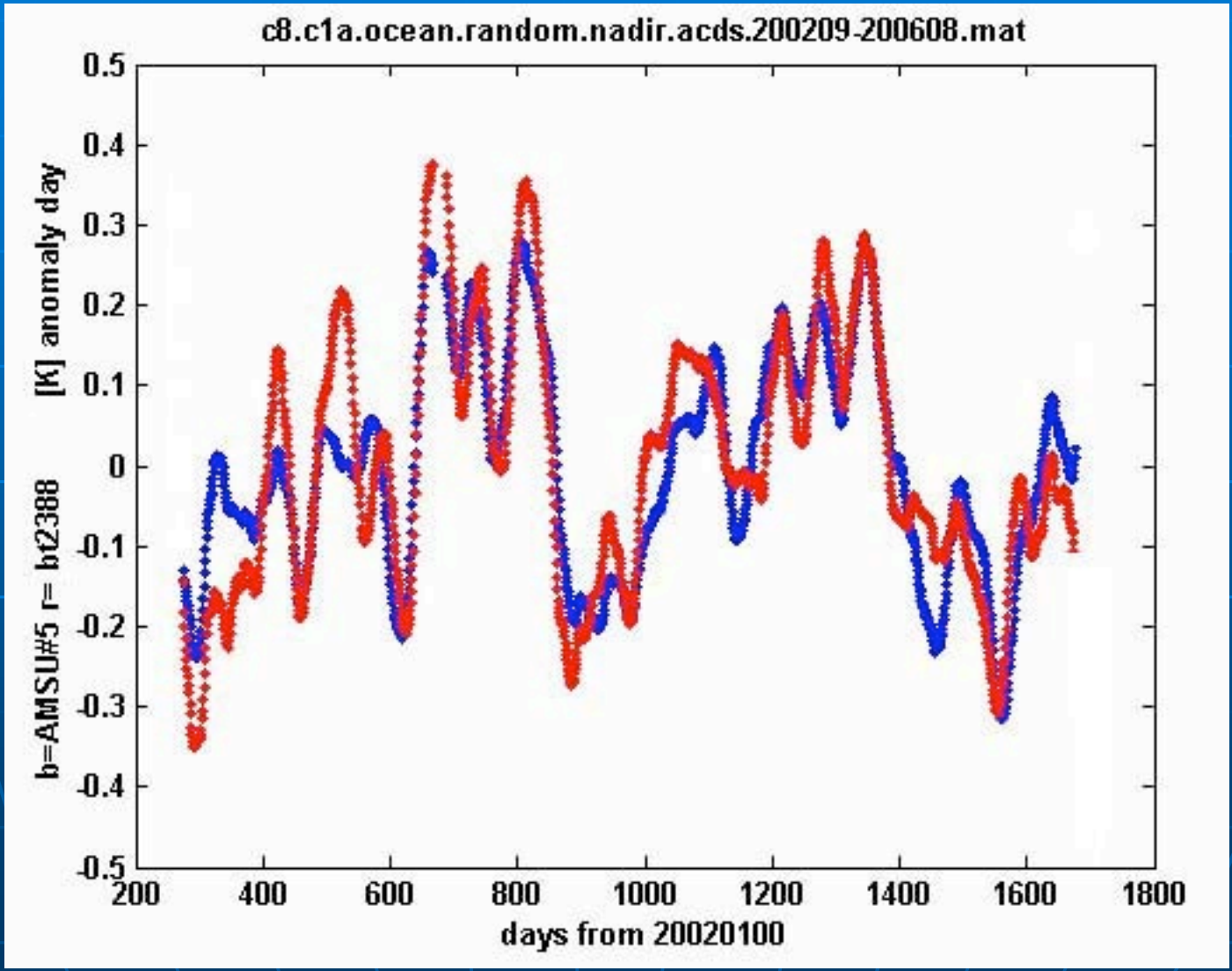
AMSU#5 and AIRS bt2388 anomaly track too well. over tropical oceans.



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AMSU#5	**day**	**-21 +/- 14 mK/year in 257.0 K**	**AMSU A1-2**
	night	**-25 +/- 12 mK/year in 257.6 K**	
bt2388	**day**	**- 63 +/- 13 mK/year in 259.0 K**	
	night	**-62 +/- 10 mK/year in 259.5 K**	
AMSU#2/0.54-sst1231	**day**	**-12 +/- 74 mK/year in 1.51 K**	**AMSU A2**
	night	**-49 +/- 76 mK/year in 0.41 K**	
AMSU#2./0.54	**day**	**+3 +/- 75 mK/year in 297.7 K**	**AMSU A2**
	night	**-98 +/- 84 mK/year in 300.0 K**	
sst1231r5	**day**	**+16 +/- 20 mK/year in 299.2 K**	
	night	**-41 +/- 17 mK/year in 299.6 K**	
bt679.9-AMSU#10	**day**	**14 +/- 10 mK/year in -1.18 K**	**AMSU A1-1**
	night	**20 +/- 11 mK/year in - 1.16 K.**	

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AMSU radiometric stability can be verified using 4 years of data at the no better than 25 mK/year level

This is good enough for weather and process studies.

It is probably not good enough for climate quality studies.

The inability to validate AMSU at the better than 25 mK/year level is partly the motivation for developing AIRS only retrievals.

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The V6.0 L1b Wish List

- L1b improved spectral calibration for climate ?
- L1c product
- AMSU L1b quality assessment

  Can 10 mK/year stability be validated for climate

?

Discussion on V 6.0 on Wednesday afternoon

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V5.0 Level 3 Features

- Level 3 Standard
  - Improved Quality
    - Quality flags in Level 2 improved per Susskind et al.
    - Subsequent increased yield and quality improvement expected.
  - Error Estimates
    - Gridded error estimates for all IR parameters for which there is a valid Level 2 error estimate
    - Reported as root sum of squares (RSS)
  - Trace gases (mean, std dev, counts, error estimate)
    - Total column CO
    - CO at 500 mb
    - Total column CH4

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V5.0 Level 3 Features

- Level 3 Standard (continued)
  - Tropopause parameters
    - Height (m), Pressure (hPa), Temperature (K)
  - Cloud profiles
    - Coarse
      - high (above 440 hPa), middle (between 680 and 440 hPa), low (between 1100 and 680 hPa)
    - Fine: Water vapor pressure layers (11)

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V5.0 Level 3 Features

- Level 3 Quantization
  - Advanced Level 3 product that takes into account the non-Gaussian distribution within a grid cell through cluster analysis.
  - Capable of capturing atmospheric variability in a more representative manner than traditional Level 3 means and standard deviations.
    - Minimizes information loss.
  - 5°x5° spatial resolution (global)
  - Pentad and calendar month temporal resolution
  - Temperature, water vapor, clouds, land fraction

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V5.0 Level 3 Features

- Level 3 Support Product
  - The level 3 product containing research parameters under consideration for inclusion into Standard Level 2 and diagnostics.
  - Derived from the Level 2 support and standard products.
  - Useful for experimentation prior to public release.
  - Level 3 support parameters selected.
  - Post V5.0 delivery to the DAAC.

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With this summary of the L1b and L3 status we now have presentation on the detail of improvements incorporated into L2

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The V6.0 L2 Wish List

- Emissivity over land ?
- Validation for polar regions ?
- Error propagation (rather than empirical errors)?

?

Discussion on V 6.0 on Wednesday afternoon